Public Review Comment Metric

Originating Office: AIR-130	Document Description: TSO-C146e	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
1.	Airbus	§3.a page 2	*"PRN range of 120 thru 156"* ⇨ The last authorized PRN is 158.	Suggested to change to "PRN range of 120 thru 158" as stated in DO-229E Appendix A §A.3.4	**Accepted.**
2.	Airbus	§3.h page 4	Reference to AC20-115 (latest revision) is more stringent that what is stated in DO-229E that refers to AC20-115C or a later revision.	Suggested to change to "AC 20-115C (or later revision)"	**Accepted.**
3.	Airbus	Appendix 2 page 2-2	*" it is recommended that manufacturers reference their equipment aircraft information security review and mitigation strategies in the equipment's installation manual so that the applicant can consider them in meeting the installation regulatory requirements."* ⇨ TSO should not ask to refer the mitigation strategies in a document that can be easily accessible	Suggested to change as follow: *" ... it is recommended that manufacturers* ***inform applicants*** *about their equipment aircraft information security review and mitigation strategies so that the applicants can consider them,* ***if necessary,*** *in meeting the installation regulatory requirements."*	**Accepted.**
4.	CMC	Section 3.a Page 2	SBAS PRN range is wrong.	SBAS PRN range is 120 thru 158 instead of 120 thru 156.	**Accepted.**
5.	CMC	Section 3.g Note 1 Page 3	Reference to paragraph 3.g is wrong.	Replace 3.g with 3.k.	**Accepted.**

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6.	CMC	Section 3.h.(1) Page 4	Reference to paragraph 3.b is wrong.	Replace 3.b with 3.e.	**Accepted.**
7.	CMC	Section 3.i.(1) Page 4	Reference to paragraph 3.b is wrong.	Replace 3.b with 3.e.	**Accepted.**
8.	CMC	Section 4.a Page 5	Missing "." at the end of the sentence. Unclear if just "." missing or if second sentence of TSO-C145d accidentally deleted.	Add ".". May also need to add "The marking must include the serial number.".	**Accepted.** Included the period at the end of the sentence. The template in Order 8150.1D no longer contains the sentence about marking with the serial number because the statement conflicts with 14 CFR 45.15(b).
9.	CMC	Section 5.o Page 8	Reference to paragraph 3.c is wrong.	Replace 3.c with 3.f.	**Accepted.**
10.	CMC	Section 6.f Page 9	Reference to paragraph 3.d is wrong.	Replace 3.d with 3.g.	**Accepted.**
11.	CMC	Section 6.g Page 9	Reference to paragraph 3.e is wrong.	Replace 3.e with 3.h.	**Accepted.**
12.	CMC	Section 7 (a) Page 9	Reference to paragraph 5.g is wrong.	Replace "3.g through 5.j" with "3.h through 5.j".	**Accepted.**
13.	CMC	Appendix 1 Page 1-2 to end.	Page 1-2 is not numbered and all subsequent pages of Appendix 1 are numbered 1-6.	Fix page numbering.	**Accepted.**
14.	CMC	Appendix 1 Section 4 (a) Page 1-4	Incomplete section name "Acquisition Time", "Reacquisition Time".	Use full section name "Initial Acquisition Time", "Satellite Reacquisition Time"	**Accepted.**

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15.	CMC	Appendix 1 Section 4 (d) Page 1-5	Reference to paragraph 3.d is wrong.	Replace 3.d with 3.g.	**Accepted.**
16.	CMC	Appendix 1 Section 4 (d) Page 1-5	"Sections 16.5.1.2 and 16.6.1.2 are for Normal/Abnormal Operating Conditions." is wrong; both sections are for noise under normal operation.	Sections 16.5.1.2 and 16.6.1.2 are for supply voltage modulation (ac) / ripple (dc).	**Accepted.**
17.	CMC	Appendix 1 Section 6 (b) Page 1-6	Reference to paragraph 3.d is wrong.	Replace 3.d with 3.g.	**Accepted.**
18.	CMC	Section 3 and appendix	In RTCA/DO-229E environmental test requirement tables, the X for Acquisition versus Reacquisition is supposed to be based on Abnormal versus Normal power input not DC versus AC power input.	TSO should put an amendment to correct this issue: Initial Acquisition Time requirement should apply to both AC and DC equipment under abnormal operating condition (DO-160E section 16.5.2 and 16.6.2) and Satellite Reacquisition Time requirement should apply to both AC and DC equipment under normal operating condition (DO-160E section 16.5.1 and 16.6.1).	**Accepted.**

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19.	Embraer	Section 1.8.3 and page 2-1.	Include a reference to DO326A/ED-202A about system information security.	DO-326A/ED-202A provides guidance to assess vulnerabilities and identification of required mitigation.	**Accepted.**
20.	Garmin	3.e.(4) Page 3	Paragraph. 3.e.(4) includes the statement: Design the system to at least these failure condition classifications consistent with the operational capability. Wording needs to change to allow failure condition to be determined at the aircraft level. This statement implies the failure condition classification of an appliance is determined by the TSO regardless of mitigations employed to meet aircraft level safety requirements such as redundant appliances/systems. Unless the DAL cannot be affected by the installation, the aircraft System Safety Assessment should determine the failure classification and by extension, the design assurance level (DAL)	Suggest changing to the alternate wording identified in paragraph 3.b. of the TSO Template in Order 8150.1D Appendix G.	**Not Accepted.** The TSO provides a design approval for the equipment based upon the intended function. For TSO-C146e, the intended function has an identified failure condition classification. The DAL a manufacturer chooses to meet that failure condition is based upon the target aircraft installation (i.e., 14 CFR Part 23, 25, 27, 29). Manufacturers can request a deviation to use a different DAL for a particular target aircraft if there is an equivalent level of safety provided thru a limitation on installation guidance to mitigate the issue.

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			requirement. The aircraft FHA/SSA ultimately determines the DAL requirement for a particular installation. Specifying the DAL at the appliance level without the benefit of the specific aircraft level FHA/SSA means that in some cases the DAL will undoubtedly be higher and more costly than necessary. This will have a chilling effect on the installation of new, safety enhancing technologies since the cost will be greater than necessary. It is possible to build and certify a TSOA appliance that cannot be approved for installation in one or more aircraft types because it does not have the required DAL. Similarly, just because the appliance meets a TSO DAL does not mean it can be approved for installation. We recommend that no failure classification/DAL requirement be included in a TSO when the installation can affect or mitigate the hazard level and therefore consideration should be given to revising paragraph 3.c in this TSO to the general guidance in the Recommendation column.		

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21.	Garmin	3.i Page 4	Including this specific DO-254 reference is redundant to the rest of the paragraph in this section. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies. DO-254 makes it clear how to address "simple" custom airborne electronic hardware.	Remove this reference to DO-254 Paragraph 1.6.	**Not Accepted.** This is specific language required by the Order 8150.1D template and is not actually redundant. If the sentence is omitted, only complex custom AEH would be referenced. See the sentence just prior to that. If reference was to AC 20-152 instead of DO-254, both simple and complex would be addressed. Although Order 8150.1D does reference AC 20-152, it only does so wrt deviations and data submittal. The intent for the reference is ensuring TSO applicants understand their responsibilities per DO-254 even with "simple" hardware. . However, this comment will be forwarded to the POC for Order 8150.1D to consider

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					changes in future revisions.
22.	Garmin	4.b.(2) Page 5	Paragraph 4.b.(2) states: Each subassembly of the article that you determined may be interchangeable. This language is confusing.	The language for this requirement is confusing. This could mean that a stuffed printed circuit board needs the TSO number. Suggest removing the statement or updating to wording identified in paragraph 4. of the TSO Template in Order 8150.1D Appendix G.	**Not Accepted.** There are two different TSO templates; one for avionics and one for non-avionics that are substantially similar but have some differences. TSO-C146e uses the avionics template which contains the specific language used. This language should not be objectionable since it gives discretion to the manufacturer to determine which subassembly is interchangeable and thus requires marking.
23.	Garmin	5.k Page 8	Paragraph. 5.k includes the statement: Identify functionality or performance contained in the article not evaluated under paragraph **3** of this TSO (that is, non-TSO functions).	1) Remove "or performance" in accordance with the GAMA non-TSO function recommendations. 2) Update Order 8150.1D	**Partially Accepted.** TSO-C146e follows the current TSO template language. However, this recommendation will be forwarded to the POC for consideration in the next update.

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			The GAMA 16-28 "Industry Recommendations on the Management of Non-Technical Standard Order Functions" Recommendation 2 recommended revising the Appendix G TSO template to remove "or performance" from the quoted paragraph 5.k statement to ensure non-TSO function definitions are "fully aligned with the original intended N8150.3 definition". This recommendation was not followed when FAA Order 8150.1D was published.	Appendix G paragraph 5.f in accordance with the GAMA recommendations. 3) Work with GAMA to address all the non-TSO function recommendations.	
24.	Garmin	5.k(7) Page 8	Paragraph 5.k.(7) includes the statement: Alternatively, identify non-TSO functionality or performance contained in the article not evaluated under paragraph **3** and submit previously accepted data for the non-TSO function for acceptance in parallel with this TSO application. This paragraph is not included in the FAA Order 8150.1D Appendix G TSO	Remove "or performance" in accordance with the GAMA non-TSO function recommendations.	**Partially Accepted.** TSO-C146e follows the current TSO template language. However, this recommendation will be forwarded to the POC for consideration in the next update.

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			template. It is unclear whether this statement is intended to respond to one or more of the GAMA 16-28 "Industry Recommendations on the Management of Non-Technical Standard Order Functions". Regardless, the statement has the same issue as identified with paragraph 5.k regarding use of the phrase "or performance".		
25.	Garmin	Appendix 2, Page numbering Appendix 3, Page number	Editorial: Page 2-2, is followed by page 2-2, 2-2, etc. Page 3-1 is followed by 3-3, then 3-3	Change Appendix x numbering to follow format of: 1st page – x-1 2nd page – x-2, … nth page – x-n	**Accepted.**
26.	Garmin	Appendix 2, Page 2-2 Section 3, REQUIREMENTS calls out Appendix 2, with new leg type requirements in section 2.2.1.3 Path Definition	Appendix 2 modifies DO-229E section 2.2.1.3 to add several more leg types. It also requires replacing section 2.2.1.3.6 to add the following leg type descriptions for FA, FM, VA, VI, VM, CA and Holding Legs HA, HF, HM. Some of these legs have additional definition in DO-283B or TSO-C115d such as 'geodesic path' vs. 'a specified	Provide more detail on how to construct the additional leg types consistent with the definition provided in DO-283B. Additional detail follows on a per leg basis.	**Accepted.**

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			track'. The addition of these leg requirements should be consistent with DO-283B which calls out more detail in Appendix D and points to a section which has rules on how to determine what MagVar value should be used.		
27.	Garmin	Appendix 2, page 2-2 2.2.1.3, Holding Legs, HA leg	HA leg is introduced with text, "Terminates at an altitude". No further guidance is given for this leg	Add text based on DO-283B D.4 to this TSO appendix: "An HA leg is a holding pattern which terminates at the next crossing of the hold fix when the aircraft altitude is at or above the specified altitude. The altitude is provided by the navigation database. The source of the magnetic variation needed to convert magnetic courses to true courses is detailed in section 2.2.1.3.12." Alternatively, the text could	**Accepted.**

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				point to DO-283B, Appendix D.4, but note that DO-283B, Appendix D.4 references the DO-283B 2.2.1.2.8 definition of magnetic course which is slightly different from the DO-229E 2.2.1.3.12 definition.	
28.	Garmin	Appendix 2, page 2-2 2.2.1.3, Holding Legs, HF leg	HF leg is introduced with text, "Terminates at fix after one orbit". No further guidance is given for this leg	Saying the hold 'terminates at fix after one orbit" differs from definition provided in DO-283B. "One orbit' could be interpreted as requiring 1 complete 360-degree track around holding pattern, which isn't the intent of the DO-283B definition. Suggest adding text based on the DO-283B D.6 definition: "An HF leg is a holding pattern which terminates at the first crossing of the hold fix after becoming established on the inbound course. This is typically after the entry	**Accepted.**

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				procedure is performed. The source of the magnetic variation needed to convert magnetic courses to true courses is detailed in section 2.2.1.3.12." Alternatively, the text could point to DO-283B, Appendix D.6, but note that DO-283B, Appendix D.6 references the DO-283B 2.2.1.2.8 definition of magnetic course which is slightly different from the DO-229E 2.2.1.3.12 definition.	
29.	Garmin	Appendix 2, page 2-2 2.2.1.3, Holding Legs, HM leg	HM leg is introduced with text, "Manual termination" No further guidance is given for this leg	Add text based on DO-283B D.5 to this TSO appendix: "An HM leg is a holding pattern which terminates only after flight crew action. The source of the magnetic variation needed to convert magnetic courses to true	**Accepted.**

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				courses is detailed in section 2.2.1.3.12." Alternatively, the text could point to DO-283B, Appendix D.5, but note that DO-283B, Appendix D.5 references the DO-283B 2.2.1.2.8 definition of magnetic course which is slightly different from the DO-229E 2.2.1.3.12 definition.	
30.	Garmin	Appendix 2, 2.2.1.3, Page 2-2	VA, VI, and VM heading leg types are not compatible with the cross-track deviation requirements in DO-229E section 2.2.1.4.1, 2.2.1.3.15, and other sections.	Suggest adding the following to the *Note* in Appendix 2, 2.2.1.3: "*Cross-track deviation requirements are not applicable for VA, VI, and VM heading leg types.*" Alternatively, similar notes could be added to the cross-track requirements in section 2.2.1.3.15 and 2.2.1.4.1. DO-229E section 2.2.1.4.1 states, "At a minimum, the non-numeric cross-track deviation shall be	**Accepted.**

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				continuously displayed in all navigation modes (either on an internal or external display)." However, cross-track deviation is not applicable when flying heading leg types.	
31.	Garmin	Appendix 2, 2.2.1.3.6, FA leg Page 2-2	The FA leg definition is not consistent with DO-283B	Revised based on text from DO-283B D.7: "An FA leg is defined by a geodesic path that starts at a fix, with a specified track at the fix and terminates at a point where the aircraft altitude is at or above a specified altitude. The outbound course from the fix, the fix, and the terminating altitude are provided by the navigation database. If the outbound course is defined as a magnetic course, the source of the magnetic variation needed to convert	**Accepted.**

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				magnetic courses to true courses is detailed in section 2.2.1.3.12." Alternatively, the text could point to DO-283B, Appendix D.7, but note that DO-283B, Appendix D.7 references the DO-283B 2.2.1.2.8 definition of magnetic course which is slightly different from the DO-229E 2.2.1.3.12 definition.	
32.	Garmin	Appendix 2, 2.2.1.3.7, FM leg Page 2-2	FM Fix to Manual termination leg definition improvement	FM leg was added as part of TSO-C115d Appendix 1 "Exceptions to RTCA/DO-283B Requirements". This TSO-C115d modification didn't add more specifics for FM legs but it could be inferred to follow the path generation guidance that is in Appendix D of DO-283B for FA legs. Suggest adding text:	**Partially Accepted.** It isn't correct to say an FM shall follow the same path definition as an FA. The following sentence was added instead: "*FM legs are similar to FA legs in terms of path construction except for manual termination versus terminating at an altitude.*"

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				"FM legs shall follow the same path definition that is used for FA legs"	
33.	THALES Avionics	Appendix 2	To address information security, the document should refer to the RTCA/EUROCAE documents on information security such as (DO-326A / ED-202A, DO-355 / ED-204, upcoming DO-356A / ED-203A). While the document, of course, may reference some active security measures as recommendations, the document should clearly promote the use of Standards.	These references should be listed in the (last) paragraph 1.8.3 of Appendix 2: Instead of "Therefore, it is recommended … meeting the installation regulatory requirements." Replace by "Therefore, it is recommended that manufacturers document their Security Assurance Level objectives to protect the main functions of equipment with a low direct impact and avoid propagating an attack to other equipment. In this purpose, supplemental guidance material may be found in RTCA/EUROCAE such as DO-326A / ED-202A, DO-355 / ED-204,	**Partially Accepted.** Draft documents cannot be referenced in the TSO, so references to DO-356A/ED-203A cannot be included. References to DO-326A/ED-202A and DO-355/ED-204 are now included at the end of the second paragraph. But, section 1.8.3 is only informational in nature and not a requirement. Manufacturers may use any reference material they choose to address cybersecurity issues.

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				DO-356A / ED-203A.	
34.	THALES Avionics	Appendix 2	It is proposed to explicitly mention that security defences and measures should be ensured by the aircraft operator all along the lifetime of the equipment use.	Adding the following sentence : "Appropriate procedures for aircraft operators should be established by Aircraft manufacturer to ensure that the approved security protection of the equipment is maintained all along the lifetime of the equipment installation in the aircraft".	**Partially Accepted.** The following sentence was added to the last paragraph as the next to last sentence: "*Additionally, aircraft manufacturers should consider establishing appropriate procedures for aircraft operators to maintain security protection of the equipment during the life of the equipment installation in the aircraft.*"
35.	THALES Avionics	Appendix 2	It is understood that equipment manufacturers should provide security information in the Installation Manual so that the aircraft manufacturer can consider them in their vulnerability risk assessment. Nevertheless, too much documenting the mitigation strategies may impair safety, by highlighting equipment vulnerabilities.		**Noted.** Section 1.8.3 is informational only and there are no instructions to document anything in the Installation Manual.
36.	THALES Avionics	3.g	It is proposed to add possibility to use RTCA/DO-160F or RTCA/DO-160G	Adding the following sentence:	**Not Accepted.** This issue was discussed at WG-2

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			without going through a deviation process. Those newest versions of DO-160 are providing an equivalent level of safety.	"RTCA/DO-160F or RTCA/DO-160G can be used as applicable environmental standards instead of RTCA/DO-160E. It is not permissible to mix versions within a given qualification program.	during the DO-229E process and the decision was to remain with DO-160E for a legacy upgrade path without a new environmental qualification. However, the last sentence in the TSO paragraph states: "*You may use a different standard environmental condition and test procedure than RTCA/DO-160E, provided the standard is appropriate for the SBAS sensor*." This provides manufacturers the ability to use later DO-160 versions without having to request a deviation. This sentence was specifically included to allow manufacturers to use other DO-160 revisions (except as discussed in note 1) without the need for a deviation.